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Paper Abstract

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Paper Title: Spacecraft Uplink, Downlink, and Intercommunications in a Space-Qualified ASIC Chip Set

Abstract: I-his paper describes the functionality of four application specific integrated circuits (ASICs) developed for the Cassini spacecraft. The four ASICs are used on the spacecraft in the Command and Data Subsystem computer to receive uplink data, transmit downlink data, and provide intercommunications within the spacecraft via a 155313 bus. Implemented in the ASICs is a portion of the spacecraft uplink and downlink protocol specified in the Consultative Committee for Space Data Systems (CCSDS) standard. 1 he CCSDS standard is a widely used, international standard, I-he ASICs also provide additional functions often required in a Command and Data Subsystem such as a spacecraft clock, a '(fault detection unit", and DMA. The ASICs, produced in Honeywell's RICMOS technology, are radiation hard, single event upset hard, and highly reliable (Class S). '1 he implementation in space-qualified ASICs of uplink, downlink, and spacecraft intercommunication functions which meet widely used standards is expected to have applications in commercial spacecraft.

The I lardware Command Decode (t ICD) ASIC is used to receive and decode uplink data. Implemented in the ASIC is the "receiving end coding layer" of the CCSDS Telecommand standard. 1 he ASIC supports the Codeblock and Command Link Transmission Unit data format specified in the standard. 1 he ASIC receives a serial, digital data stream of uplink data from the antenna receiver electronics. I-he ASIC will perform one of two types of error detection/correction on the uplink data: single bit error correction and double bit error detection; or triple bit error detection (no correction), 1 he ASIC also supports direct ground control of up to 32 relays and 24 discrete outputs via

Virtual Channel O commands. These relays and discrete outputs allow ground control of critical functions independent of the flight software, The ASIC also contains a "fault detection unit" which provides a watchdog timer, interrupt control support, reset control, and eight discrete outputs which support the exchange of system "health" and other information between redundant systems.

The Reed-Solomon Downlink (RSDL) and Solid State Recorder Interface (SSRIU) ASICs together provide telemetry channel encoding as per the CCSDS standard. The ASICS manage a double buffer which is loaded with transfer frames of telemetry data either through a parallel port or serial port. The ASICs append a "sync marker" to the front of each transfer frame, calculate Reed-Solomon check bits, append the check bits to the end of each transfer frame, and transmit a serial, digital data stream of telemetry data to the antenna transmitter electronics, The ASICs also contain a 46 bit spacecraft clock which can be used by software to trigger timed-based events.

The Cross-String Bus Adapter (XBA) ASIC is used in conjunction with the UTMC BCRTM chip to function as either a 1553B Remote 1 erminal or Bus Controller. The 1553B protocol is implemented in the UTMC BCRTM chip. The XBA ASIC provides a software interface to the BCRTM registers and 32 kwords of buffer RAM. In addition, the ASIC also provides a DMA capability which allows the direct transfer of data between the 1553B bus and the host computer memory without software intervention, 1 he ASIC also contains a watchdog timer, memory error detection and correction, and other features.

All four ASICs interface to the host computer via an ISB bus, which is a 16-bit, parallel, fully-interlocked, asynchronous, multi-master bus. A space-qualified field programmable gate array is currently under development which will allow the ASICs to interface to a VME bus,